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IMPLICATIONS FOR DEVELOPING COUNTRIES OF RECENT TECHNICAL ADVANCES IN THE PRODUCTION OF PULP AND PAPER

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Implications for Developing Countries of Recent Technical Advances in the Production of Pulp and Paper

by Hans Wilhelm Giertz

1. Until fairly recently papermaking was an art which could only be learnt through a long apprenticeship. The rapidly-growing demand, resulting in mass production of many paper qualities, and the increasing need for speciality products, gradually forced producers to carry out fundamental and applied research directed to improving and developing manufacturing techniques. As a consequence, the postwar decade has witnessed a rapid evolution in the science and technology of pulp and paper manufacture and we have today a much clearer understanding of some of the factors which influence the characteristics and properties of the final product.

2. Generally speaking, most ligno-cellulosic and cellulosic materials of fibrous structure may be processed into some grades of papers and paperboard. Fibres from different raw materials are, however, not alike. They differ considerably in their morphological and chemical characteristics, which make them more or less suitable for papermaking.

3. There are two main reasons why today more than 90 per cent of all the pulp that goes into paper and board manufacture comes from conifers:

(a) The prevalence of coniferous resources in the industrialized regions which account for the preponderant share of the world's consumption and output of pulp and paper and;

(b) The present technical advantage of the long fibres of the conifers over the shorter fibres of deciduous woods and agriculture residues.

4. Among coniferous woods, spruce and other species of the same type such as fir, balsam and hem-lock have occupied a favoured position due to the following reasons:

(a) The wood is soft and has low resin content, making it suitable for grinding

(b) The absence of phenolic heartwood substances such as pinosylvin in combination with the long fibre length make it the most suitable raw material for the sulphite industry

(c) Sulphite pulp was the only type of pulp which could be bleached to high brightness, and

(d) Sulphite pulp was the only type of pulp which could be used for viscose and other dissolving purposes.

The Use of Short Fibre Pulps

5. As will be shown below the pulping and bleaching processes have been developed to such an extent that all kinds of raw materials can be pulped today. For a long time, however, it was considered necessary to use long fibres, i.e. with a fibre length of 2-4 mm, for all kinds of paper, and short fibre pulps, primarily in the form of bleached soda pulps, were only used to a very limited extent as filler pulps. This situation has changed drastically in the last two decades.

6. In the manufacture of printing and writing papers good sheet formation is of greatest importance. Long fibres have always a tendency to flocculate and in order to overcome bad formation when using long fibre pulps the papermaker has to shorten the fibres by beating. Beating, however, adversely influences other and important properties of the paper such as bulk, opacity and tearing strength. When using short fibre pulps good formation is obtained automatically and only a low degree of beating is needed to obtain the necessary sheet strength. At the same time short fibres contribute to smoother surface and higher opacity.

7. It is today a well established fact that the use of short fibre pulps offers a series of advantages in the production of fine papers. It is therefore a tendency to use more and more such pulps in the fine paper industry. Furnishes consisting of 50 per cent short fibre pulps are today ordinary practice in fine paper mills and in many cases 80 per cent is used. Some printing papers are commercially manufactured from 100 per cent hardwood pulp, but for most purposes it is considered necessary to add about 20 per cent of a long fibre pulp to increase the wet strength of the paper web when passing through the press section of the paper machine. This holds specially for fast running machines.

8. In the case of kraft papers, such as wrapping paper and multi-wall bag paper, the requirement in strength is the most important one. For low grade wrapping papers the furnish can be made up of 100 per cent short fibre pulp, or close to it, but in order to meet international standards long fibre pulps have to be added, the extent of which varies with the type of paper.

9. This problem has been studied extensively in Australia where the main raw material for domestic pulp production is short fibre eucalypt wood. Wrapping kraft papers and grocery bag krafts contain 50-60 per cent eucalypt kraft pulp. The most exacting requirement of these products is a high tearing strength and this restricts the amount of eucalypt pulp that can be used. Multiwall bag kraft, which for instance is used for cement and fertilizer sacks, is produced from 35 per cent eucalypt kraft. In this case the specifications for tear and tensile strength are very high.

10. In Mexico and Peru bagasse pulp is used for the same purposes.

11. As will be mentioned later the new technique of making extensible kraft papers might change the ratio of long to short fibre pulps in favour of the short fibre portion.

12. Corrugating board is made of one or several layers of "corrugating medium" covered on one or both sides by "kraft liner" or "chip board". Corrugating

medium used to be and still is to a very large extent produced from waste paper. The same holds for chip board. It is, however, today a well established fact that the best corrugating medium product is manufactured from a neutral sulphite semi-chemical short fibre pulp. Kraft liner is conventionally made of regular pine kraft pulp but also in this case hardwood kraft can be used to a large extent. One mill in Japan produces kraft liner containing 70 per cent mixed hardwood pulp.

13. It is thus clear that for the most important grades of papers, except newsprint, which will be dealt with later, short fibre pulps can be used completely or to a very large extent. What has been said about short fibre pulps in general holds as well for broadleaved wood pulps as for bagasse, straw and other agriculture residue pulps. Bamboo pulp, on the other hand, should be classed as a long fibre type pulp, the bamboo fibres being 2-3 mm long.

Pulping Processes

14. The kraft process is applicable to all kinds of raw materials, such as coniferous woods, all types of broadleaved woods, straw, bagasse and bamboo. The pulp obtained is for each kind of raw material of highest quality. A minor disadvantage is its brown colour and the difficulties involved in bleaching the pulp. The main disadvantage, however, is that the consumption of chemicals in the kraft process is extremely high and amounts to about 400 kg of sodium-hydroxide per ton of pulp. As a consequence the chemicals have to be recovered, and as the equipment needed for the recovery is complicated and expensive, kraft mills have to be built in large units with high capacity.

15. The conventional acid calcium sulphite process is not based on the recovery of chemicals and sulphite mills can therefore be built economically in smaller units than kraft mills. The sulphite process has, however, shown its limitations. For chemical reasons well-known today, it is only possible to cook certain wood species, such as spruce, fir , balsam and hemlock; pine heartwood and other resinous and dense species are not digestible, and most hardwoods and all kinds of "open raw materials", such as straw and bagasse, give very soft pulps. In recent years, however, the fundamental knowledge on sulphite cooking has increased significantly and new types of sulphite cooking seem to offer possibilities of great interest.

16. In the last 20 years the neutral sulphite process has developed rapidly. The process is semi-chemical and the cooked chips have to be defibrated by mechanical means in order to obtain a workable pulp. The pulp is therefore only used for certain grades of paper and mainly for corrugating medium. All kinds of raw materials can be used, hardwood, straw and bagasse being the most suitable. The only base which can be used is sodium, but the consumption of chemicals, which amounts to about 150 kg of sodium sulphite per ton of pulp, is anyhow so low that the process can be economically performed without the recovery of chemicals.

17. In the very last years the so-called bisulphite process has attracted great interest. Today there are a number of mills operating according to this process, some of which are converted sulphite mills and some are mills built specially for this process.

18. Bisulphite cooking is performed under slightly acid conditions at pH 3-5 with a cooking liquor consisting of mainly bisulphite and without excess SO_2. The base can be either sodium or magnesium. Compared with neutral sulphite cooking at pH 7-9, the bisulphite liquor is acid enough to hydrolyse and dis-

solve the lignin. The delignification is therefore fairly complete and results in well cooked chips and a workable pulp. On the other hand, the liquor is not as acid as in conventional acid sulphite cooking (pH 1-2) which means less hydrolysis and thus a higher yield and a stronger pulp. Unbleached, chemical pulps from coniferous woods, are obtained in a yield of about 60 per cent of the wood, compared with 50 per cent for ordinary sulphite and kraft pulps. Bleached pulps, however, are only of somewhat higher yield than conventional bleached pulps. Strength is higher than for ordinary sulphite pulps and can in some respects be compared with that of kraft pulps.

19. An important advantage of bisulphite cooking is that most kinds of raw materials can be cooked. Ordinary sulphite woods as well as pine, including pine heartwood, and different hardwoods are successfully digested in existing mills. For other raw materials such as straw, bagasse and bamboo, the experience is limited.

20. The consumption of chemicals depends greatly on the degree of cooking and the yield of the pulp. Among existing mills some are operating economically without recovery. This holds both for unbleached and bleached pulps, and both for sodium and magnesium base. The fact that the recovery of chemicals is not necessarily needed makes it economically feasible to build small mills (50 daily tons) based on the bisulphite process.

21. In this connection it should be pointed out that there is no fundamental difference in neutral sulphite and bisulphite cooking and that in a bisulphite mill the production can easily be switched over from one type to the other. This makes it possible to cover a very wide range of qualities, from semi-chemical pulps to bleachable grades.

22. Newsprint offers a problem of its own. 75-85 per cent of the furnish consists of mechanical pulp which used to be made of spruce or other woods of the same type.

23. The pitch trouble, which used to arise when using pine groundwood, has now been overcome and many mills all over the world are now producing newsprint from pine wood, which in countries like Chile, South Africa and New Zealand is taken from plantations. At the same time the necessary chemical pulp is semi-bleached pine kraft pulp instead of unbleached spruce sulphite.

24. The grinding of broadleaved woods has still not got its general solution. In the case of light coloured, soft species like poplar, aspen, willow and certain eucalypt species (Tasmania) the mechanical pulp obtained is acceptable for newsprint and magazine papers, but due to lower strength compared with spruce groundwood the portion of chemical pulp has generally to be increased. Dense or coloured hardwoods, to which group most of the tropical trees belong, do not yield an acceptable groundwood with the present grinding technique.

25. The grinding of dense hardwoods has, however, got an acceptable solution in the so-called attrition processes. The chips are first chemically softened and then fiberized in some type of disc refiner. The pulp is obtained in a yield of 80 per cent or higher and is of the same general character as groundwood. This quality can be varied within certain limits and the product substitutes partly the mixture of groundwood And chemical pulp. The chemical presoftening process can be performed either by some kind of neutral sulphite or bisulphite treatment, which has to be done at elevated temperature and under pressure, or according to the newly developed cold soda process. In the latter case and when using a coloured wood raw material the pulp has to be bleached with hypochlorite, peroxide or hydrosulphite. The conversion costs are higher

than for regular groundwood, but this can be more than balanced by the low cost of the hardwood that can be used.

26. A large number of mills of this kind are now in operation all over the world and the pulp is substituting groundwood in newsprint, magazine paper and other low quality printing papers. The new mill at Kulna, Pakistan, is of special interest, because it is based on a domestic broadleaved wood, (gewa) which is partly used as conventional groundwood pulp and partly as a semi-chemical attrition pulp. The long fibre portion consists of an imported semi-bleached sulphate pulp.

27. This new attrition technique is of great interest because it shows that groundwood type pulps can be produced economically from a number of technically important hardwood species which earlier were considered to be of no industrial interest.

28. In this connection it should also be mentioned that processes have been worked out according to which bagasse can be used for newsprint. One mill of this kind is to be built in India.

29. The acid sulphite process is considered to be the most suitable process for the manufacturing of rayon pulp and other types of dissolving pulps. The product is easy to bleach and is of high purity and reactivity. As a consequence, spruce-type woods have been the dominant raw material for the rayon pulp industry.

30. In recent years, however, the development of so-called prehydrolysis-sulphate process has made it possible to use other raw materials than spruce for this purpose. According to this process the digestion starts with a hydrolytic steam treatment at high temperature followed by an ordinary kraft cook. The yield is comparable to that obtained by the acid sulphite process (30-35 per cent) and the product is of very high quality for use in the viscose industry. All kinds of raw materials can be handled. Several mills are based on pine and hardwoods and one on reeds. One mill is under erection in India using bamboo as raw material. The expensive recovery system, however, which is the same as for a regular kraft mill, makes it necessary to build mills of this type in large units.

Papermaking

31. In the field of papermaking the dominant trend in the postwar years has been to increase machine speed in order to raise the production. A prerequisite for high machine speed is a well-trained labour staff. At the same time there has been a tendency to build specialized paper machines, each machine being constructed for a certain type of product. The experience gained in both these fields is of a limited interest for a new paper industry in a developing country. There are, however, some trends in modern papermaking techniques which should be mentioned.

32. The principles of separate beating of paper pulps is now becoming more clearly understood. Separate beating is practised in cases where pulps of quite different character are used together, such as long fibre and short fibre pulps. This technique, which was developed in Australia, makes it possible to increase the portion of the short fibre pulp both in the case of kraft papers and fine papers. It is also present experience that the type of

beater and refiner should be carefully adapted to the type of pulp to be treated.

33. When increasing the speed above 500 mpm on newsprint machines the development of the vacuum pick-up unit was necessary to make it possible to transfer the wet sheet from the wire to the first press. Because of its high cost such a unit is only used on high speed machines and above all on highly specialized newsprint machines. It should, however, be mentioned that the vacuum take-off technique could also be a means of increasing the portion of short fibre pulp in the case of paper machines operating in the medium speed range.

34. For many types of paper, and specially for multiwall sack paper, the extensibility of the paper is of importance. To meet international standards the main part of the furnish has to be a long fibre kraft pulp as has been already pointed out.

35. In recent times methods have been developed according to which the paper, when still wet, is compressed on the paper machine making it extensible after drying. Such papers have shown to possess quite new properties making them especially suitable for purposes like grocery bags and multi-wall sacks. Furthermore, in cases where long and short fibre pulps are mixed, it has been shown to be possible to increase the portion of short fibres, and still keep the properties of a typical kraft paper. One paper mill in Peru is operating according to this process, manufacturing kraft papers with a large portion of bagasse pulp.

36. An ordinary paper machine is not adapted to produce a wide range of different paper qualities and especially not paper and boards varying widely in basis weight. This is a disadvantage of great importance for developing countries.

37. In present times, a new paper machine design is being developed and some units are already in commercial operation. The principle is that the wet web is dewatered upwards instead of downwards, making it possible to apply one layer on the top of the other and still having a very rapid dewatering process. Such machines can operate in the speed range of 50-350 mpm, depending on basis weight, and it is possible to produce paper and boards with greatly varying basis weight. Thus it is expected to be possible to produce on one machine all types of papers, such as tissue, newsprint, kraft papers, printing and writing papers, corrugating medium and kraft liner and at the same time chip board and other boards of not so high basis weight. It should be pointed out that such an all round paper machine is still not in commercial operation.

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